UTILITY APPLICATION

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FITTING REMOVAL TOOL

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FITTING REMOVAL TOOL

FIELD OF THE INVENTION

This invention relates generally to hydraulic fitting removal tools and, in particular, to an aircraft hydraulic/pneumatic fitting removal tool used for disengaging the locking mechanism used by certain aircraft hydraulic fittings.

BACKGROUND OF THE INVENTION

Modern aircraft, specifically commercial aircraft, frequently utilize high pressure fluid circuits commonly referred to as pneumatic or hydraulic systems to control and operate a wide variety of aircraft systems. From flight control systems such as flaps and ailerons to engine systems such as thrust reversers and safety systems such as door latches, hydraulic/pneumatic systems have proven highly reliable and generally superior to other systems. It is therefore not surprising that a modern commercial aircraft may have many miles of hydraulic pathways.

Although a common and often desirable characteristic of hydraulic/pneumatic systems is that the piping may be flexible and or formed into a variety of shapes, substantially rigid fittings are typically used to connect the ends of piping to housings or other structures. During operation, an aircraft may be subject to a number of vibration forces. In some instances these vibrations may be sufficient to loosen fittings. To combat this loosening tendency, fittings have been developed with locking systems intended to keep them in place and resist loosening over time, whether due to vibration or other stresses.

The developer of the present inventions, Honeywell International, Inc., has for years successfully designed, developed, manufactured and repaired aircraft hydraulic/pneumatic circuits and systems. One style of fittings frequently used is provided by Lourdes Industries, Inc. of Tucson, Arizona.

FIG. 1A shows a fitting **101** commonly referred to as a Lourdes fitting **101**. Through the center of the fitting **101** runs a hollow passage, illustrated by dotted lines **103**, from the open end **105** to permit the flow of hydraulic/pneumatic fluids through the fitting **101**. This style of fitting **101** employs a locking collar **131** to prevent unintentional loosening of the fitting **101**.

In general, the locking collar **131** is characterized as a ring with a circumferential groove **133**, dividing the collar into what may appear as two fused rings, an inner ring **135** and an outer ring **137**. Frequently the ring proximate to the mounting threads (the inner ring **135**) is smaller in outside diameter then the ring farther away (the outer ring **137**). The exterior surface of the locking collar **131** is characterized by vertical serrations or spines

139. The interior surface of the locking collar is mated to a plurality of vertical grooves **107** in the sidewall of the fitting body **109**. These grooves insure that while the locking ring may be moved laterally along longitudinal axis **111** of the Lourdes fitting **101**, represented by arrows **113**, the fitting **101** cannot rotate independently from the locking collar **131**. As desirable as these features may be during installation and for insuring that the fitting does not inadvertently loosen, they are often the source of great frustration to the technician attempting removal of the fitting.

After the fitting has been properly screwed into place, the locking collar **131** is pressed, pounded, or otherwise forced down into a provided annular groove in the mounting surface **183**. The vertical grooves **107** are generally then visible above the locking collar **131** as shown in FIG. 1B. When the locking collar **131** has been properly forced down into the annular groove, the spines **139** of the locking collar **131** bind upon the material of the mounting surface **183**. This binding action results in a firm hold that generally prevents the fitting from **101** unintentional loosening.

Removal of the Lourdes fitting **101** may be desired for a variety of maintenance tasks. To remove the Lourdes fitting **101** from the housing surface **183** into which it has been set, the locking collar **131** must be retracted from it's inset nested position. The circumferential groove **133** and the outer ring **135** of the locking collar **131** provide a location upon which a lever can be applied. For example, a technician may attempt to insert the tip of a blade screwdriver into the groove and pry the locking collar away from the housing. Such prying is generally quite difficult. The technician may also attempt to use some form of an axial pulling device.

Aircraft design and the conservation of weight and space continue to advance components into closer and tighter arrangements. It is now not uncommon for a desired Lourdes fitting to be installed in a location where it is extremely difficult if not nearly impossible for a technician to disengage the lock ring by traditional methods. Often, removal of the housing, and/or other components, may be required simply to provide sufficient access space for a prying screw driver to be applied.

Presently available and known fitting puller tools **161**, shown in FIG. 1B, utilize expanding graspers such as hooks **163**, or expanding halves **165** such as the Fairchild Fasteners Rosan fitting puller **167** shown in FIG. 1C. Use of either type of pulling device requires the target fitting **101** to be positioned well away from other structures **181**, contoured surfaces **183** and/or components. More specifically, in order to grasp the fitting **101** to be pulled, the puller **161** first expands radially so that the grasping apparatus (hooks **163** or halves **165**) can be placed around the target fitting **101**. This radial expansion often

results in the pulling device, (**161** or **165**) having a diameter that is significantly larger than the target fitting **101** – perhaps even by 100%. Such a tool is completely unworkable in a setting where the fitting **101** is placed so closely to a component **181** that the puller can not align with the fitting **101** and or properly grasp the locking collar **131**.

As stated above, the Lourdes fitting is designed to permit the passage of fluid through itself in line with it's longitudinal axis **111**. Each end of the fitting is open and generally conically shaped to mate properly with connecting hosing or ports. As a result, the exposed end of an installed Lourdes fitting **101** does not provide a solid contiguous surface perpendicular to it's longitudinal axis **111** that a traditional pulling device may use as a fulcrum. Attempts to use traditional pulling devices may significantly damage the tapered end of the fitting, the locking collar **131,** the spines **139**, the vertical grooves **107**, and or the fitting **101** itself, rendering the fitting **101** unable to properly seal with a connecting line. Traditional pulling devices may also damage, bend and or scrape the opening **105** and in so doing introduce foreign material (such as metal shavings or other debris) into the hydraulic/pneumatic circuit. Despite the high cost of such fittings, the relative probability of harm to the fitting is perceived as being so significant that generally all removed fittings are simply discarded.

Further, given the limitations of space it is often difficult for a technician to use more than one hand at a time due in part to limitations of space and or line of vision. The complexities of the tool and it's method of attachment may require the technician to apply both hands to hold the tool while a second technician attaches a wrench or retaining clamp. For example, the Rosan fitting puller **167** may require the outer housing **169** to be driven down onto the expanding halves **165** in order to set the tool upon fitting **101**.

Hence, there is a need in for an improved aircraft fitting removal tool with improved characteristics to overcome one or more of the drawbacks identified above. The present invention satisfies one or more of these needs.

SUMMARY OF THE INVENTION

The invention provides an aircraft hydraulic/pneumatic fitting removal tool and related method of use for disengaging the locking collars of such fittings.

In particular, and by way of example only, according to an embodiment of the present invention, this invention provides a fitting removal tool for retracting the locking collar of an open ended hydraulic/pneumatic fitting. The removal tool provides a seat structured and arranged to seat against the open end of the fitting; a housing structured and arranged to house the seat; an adjustable actuator structured and arranged to laterally

actuating the seat within the housing; a swivel structured and arranged to maintaining the seat in a given orientation; and an attacher integral to the housing, the attacher structured and arranged to attach the housing to the locking collar of the fitting.

Moreover, according to an embodiment thereof, the invention may provide a fitting removal tool for retracting the locking collar of an open ended hydraulic/pneumatic fitting, the removal tool characterized by a housing having an internal channel partially along a longitudinal axis. A swivel seat is disposed within the internal channel and is configured to engage the open end of the fitting. An adjustable actuator is coupled to the swivel seat and configured to laterally actuate the swivel seat within the internal channel. An attacher, integral to the housing, is also provided and configured to attach the housing to the locking collar of the fitting.

In another embodiment, the invention may provide a fitting removal tool for retracting the locking collar of an open ended hydraulic/pneumatic fitting, the removal tool characterized a right cylindrical housing having a first end, a second end, a longitudinal axis therebetween. Further the housing may provide a base in the first end, an internal pocket, proximate to the second end and transverse to the longitudinal axis and an aperture in the second end, concentric to the longitudinal axis. An internal channel, concentric to the longitudinal axis extends from the pocket towards the first end. A swivel seat is coupled to the adjustable actuator and disposed within the internal channel.

In yet another embodiment, the invention may provide a method of retracting the locking collar of an open ended hydraulic/pneumatic fitting using a removal tool. The removal tool is characterized by a cylindrical housing having a first end, a second end, a partially exposed internal channel concentric to the longitudinal axis, a pocket transverse to the longitudinal axis and proximate to the housing second, an adjustable actuator extending through the first end into the internal channel and joined to a swivel seat disposed and laterally actuated within the internal channel. The method of removal involves actuating the adjustable actuator in a first direction to retract the swivel seat within the slot and placing the removal tool parallel to the fitting such that the partially exposed internal channel and pocket are presented to the fitting. The pocket is then slip-fit over the locking collar of the fitting. Actuating the adjustable actuator in a second direction advances the swivel seat to engage the open end of the fitting. Force is then applied by driving the adjustable actuator in the second direction, the force through the base providing a lateral motion of the cylindrical housing relative to the swivel seat engaging the open end of the fitting.

These and other features and advantages of the preferred apparatus and method will become apparent from the following detailed description taken in conjunction with the accompanying drawings which illustrate, by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a prior art hydraulic/pneumatic fitting;

FIGS. 1B and 1C illustrate prior art pulling devices attempting removal of the fitting in FIG. 1A;

FIG. 2A shows a fitting removal tool according to a preferred embodiment of the present invention;

FIG. 2B shows a cutaway of the fitting removal tool shown in FIG. 2A;

FIG. 2C shows an exploded view of the fitting removal tool shown in FIG. 2A;

FIG. 2D shows an enlarged end view of the fitting removal tool shown in FIG 2A;

FIGS. 3A through 3C illustrate use of the fitting removal tool shown in FIG. 2A;

FIG. 4 shows the fitting removal tool shown in FIG. 2A attached to the fitting of FIG. 1A.

DETAILED DESCRIPTION

Before proceeding with the detailed description, it is to be appreciated that the present invention is not limited to use or application with a specific type of aircraft hydraulic/pneumatic fitting removal tool. Thus, although the present invention is, for the convenience of explanation, depicted and described with respect to one type of aircraft hydraulic/pneumatic fitting employing an annular locking collar, this invention may be applied to other types and styles of fitting removal tools.

Turning now to the drawings, FIG. 2 shows a fitting removal tool **200** embodying the present invention. The fitting removal tool **200** has a right cylindrical housing **202**, an actuator **240** and a swivel seat **270**. These components may be more fully appreciated with reference to the cutaway and exploded views provided in FIG. 2B and 2C.

The housing **202** may be characterized as having a longitudinal axis **204**, first end **206**, a second end **208**, a base **210** for the actuator **240**, an internal circumferential pocket **212**, an aperture **214**, and an internal hollow channel **216**. As shown, the first end **206** and second end **208** are substantially transverse to the longitudinal axis **204**. The base **210** may be located in the first end **206**, and in at least one embodiment the base may include a threaded hole **218** concentric to the longitudinal axis **204**. The pocket **212** may be proximate to the second end **208** and transverse to the longitudinal axis **204**. The aperture

214 may be located in the second end **208** concentric to the longitudinal axis **204**, and accessing the pocket **212**. To maintain the outer boundary of the pocket **212**, the diameter **220** of the aperture **212** is smaller than the diameter **222** of the pocket **212** (see face view of second end FIG. 2D). The internal hollow channel **216** is concentric to the longitudinal axis **204** and extends from the inner boundary of pocket **212** towards the first end **206**.

So as to permit the fitting removal tool **200** to grasp the locking collar **131** of a fitting to be removed, an opening **224** is provided in the side of housing **202**. In the depiction, the opening **224** extends from the housing second end **208** to about halfway to the housing first end **206**, and laterally exposes a portion of the internal hollow channel **216**, the pocket **212** and the aperture **214**. In at least one embodiment, the opening **224** and exposed portions of the hollow channel **216**, the pocket **212** and the aperture **214** are appropriately sized and shaped to permit the housing **202** to be slip-fit over a fitting **101** intended for removal. A viewing window **226** may be provided opposite from the opening **224** so that the technician may view the fitting **101** from both sides of the fitting removal tool **200**.

As used herein, the terms of "slip-fit" shall be understood and appreciated to imply that tilting the housing **202** is not required to place the housing about the fitting **101**. Moreover, when the fitting removal tool **200** is oriented to be next to, and substantially parallel to, the fitting **101**, a sliding motion perpendicular to the longitudinal axis **204** will place the housing **204** substantially about the fitting **101** while maintaining substantial parallelism.

The outside diameter **228** of the housing **202** may be substantially uniform across the entire length of the housing **202** (see FIGS. 2A and 2D). In addition, in at least one embodiment the outside diameter of the housing **202** is substantially equal to or less than the outside diameter of the drive socket initially used to install the fitting **101**. Further, the diameter of pocket **212** is substantially preset and non-expandable, requiring no radial expansion to engage the fitting **101**.

In at least one embodiment, the adjustable actuator **240** is a threaded rod **242** coupled to a grip **244**. Threaded rod **242** passes through mated threaded hole **218** in the first end **206** of the housing **202**. As shown, the longitudinal axis **246** of the threaded rod **242** substantially matches to the longitudinal axis **204** of the housing **202**.

Grip **244** may be sized and shaped to be easily grasped and rotated by a technician. More specifically, as grip **244** is rotated by a technician, the rotation of grip **244** is directly imparted to threaded rod **242**. Grip **244** may further provide a socket **248** of an appropriate nature to accommodate removably attaching a lever or driver, such as, for example, a three-

eights inch square ratchet driver. It is understood and appreciated that rotation, represented by arrows **250**, of grip **244** imparts lateral motion, represented by arrows **252**, to threaded rod **242** towards or away from pocket **212** (see FIGS. 3A and 3B).

Opposite from the grip **244**, the threaded rod **242** may be appropriately sized and shaped to join with swivel seat **270**. More specifically, the end **254** may be rounded and provide an attacher **256** suitable for joining the threaded rod **242** to the swivel seat **270**. In at least one embodiment such an attacher **256** may be a circumferential groove **258** substantially transverse to longitudinal axis **246**, and associated snap ring **260**.

In at least one embodiment, threaded rod **242** and grip **244** may be fabricated from a unitary block of metal. Under appropriate circumstances, other methods of coupling the rod **242** to the grip **244** may be employed such as glue, welding, press fitting, threaded fitting, or set screws.

The threads of rod **242** and the threads of mated threaded hole **208** may be sufficiently fine and snug to each other such that threaded rod **242** will remain at a fixed position when the technician ceases rotation of grip **244**. More specifically, threaded rod **242** may support a load force without spontaneous rotation.

As shown in FIG. 2B, the swivel seat **270** is disposed in the internal hollow channel **216** and joined by the attacher **256** to threaded rod **242**. The swivel seat **270** is structured and arranged to seat against an aperture, and more specifically, to do so without damaging the aperture or it's surrounding material. With respect to fitting **101**, the aperture is the open end **105** of the fitting **101**.

In at least one embodiment, the swivel seat **270** includes as a hollowed cylindrical body **272** having a longitudinal axis **274**, a first end **276**, a second end **278**, an internal cylindrical opening **280**, and a pilot **282** (see exploded view FIG. 2C). The internal cylindrical opening **280** extends from the second end **276** inwardly towards the first end **278**. The internal cylindrical opening **280** is sized to accept the rounded end **254** of the threaded rod **242**.

The pilot **282** is substantially perpendicular to the first end **278** and extends concentrically along the longitudinal axis **274**. The outside diameter of the pilot **282** may be sized to about the same dimension as the inside diameter of the open end **105** of the fitting **101**, the pilot thereby snuggly fitting within the open end **105** of the fitting **101**. In addition, the distal end **284** of the pilot **282** may be conically tapered to assist with aligning the pilot **282**, and thereby the fitting removal tool **200**, with the fitting **101**. More specifically, pilot **282** advantageously permits the swivel seat **270** to engage the open end **105** of fitting **101**.

Around the internal sidewall **272** of the opening **280**, and transverse to the longitudinal axis **274**, a circumferential groove **274** is preferably formed. The internal circumferential groove **274** may be appropriately sized and shaped to receive the snap ring **260** of threaded rod **242** as end **254** is inserted into the opening **280** to join swivel seat **270** to threaded rod **242**.

A friction reducing material such as oil, graphite, Teflon or other lubricious material tending to promote easy swiveling may also be applied or deposited to / between the end **254** of the threaded rod **242** and the internal cylindrical opening **280** of the swivel seat **270**. The swivel seat **270** maintains substantially a constant orientation relative to the engaged open end **105** of the fitting **101** as the threaded rod **242** is rotated. Swivel seat **270** advantageously permits the fitting removal tool **200** to engage the open end **105** of the fitting **101** and apply a substantial pulling force without marring, gouging, scraping, or otherwise damaging the precisely machined conical end **113** of the fitting **101**.

In the assembled form of the fitting removal tool **200**, the longitudinal axes (**204**, **246** and **274**) are substantially aligned. As such, rotation of threaded rod **242** results in transitive motion of the housing **202** towards the grip **244** with the swivel seat **270** engaged to fitting **101**.

The integral nature of the pocket **212** to the housing **202** directs that as overall housing **202** moves, so to does the pocket **212**. Engaging the locking collar **131**, the lateral motion of the pocket **222** towards the grip **244** affectively disengages the locking collar **131** from the mounting surface **183**, thus permitting the fitting **101** to be removed.

It is appreciated that fitting removal tool **200** permits extraction of the locking collar **131** without imparting significant torsion stress or rotation force to the fitting **101**, either of which are likely to damage the serrations of the locking collar, the mounting flange, the open end **105** of the fitting **101**, and/or the fitting **101** itself. Advantageously, fabricated with an outside diameter **228** substantially similar to that of the socket used to install the fitting **101**, use of the fitting removal tool **200** generally is not impeded by close structures **181**, as conceptually illustrated in FIG. 4.

It is further appreciated that the fitting removal tool **200** is sized and arranged to facilitate easy deployment by a technician as a one-handed tool. In addition, the external surface of the cylindrical housing **202** and or the grip **244** may be knurled or otherwise machined, coated or treated to facilitate easy manipulation by the technician.

Having described the above physical embodiment of the fitting removal tool **200**, another embodiment relating to the method of employing the fitting removal tool **200** to disengage the locking collar **131** of a fitting **101** will now be described with reference to FIGS. 3A, 3B and 3C. It will be appreciated that the described method need not be performed in the order in which it is herein described, but that this description is merely exemplary of one method of using the fitting removal tool **200** in accordance with the present invention.

As noted above, modern aircraft incorporate substantial numbers of hydraulic/pneumatic fittings **101** many of which are frequently mounted in limited access locations. The presence of a fitting **101** generally suggests that there is sufficient surrounding space to accommodate a drive socket as may have been employed to install the fitting **101**.

In general, the technician may commence the removal process by rotating the grip **244** to retract the swivel seat **270** within the internal hollow channel **216**, shown in FIGS. 2A ~ 2C. Generally the swivel seat **270** is retracted such that opening **224** is substantially unobstructed and ready to receive the exposed portion of fitting **101**. The technician now positions the removal tool **200** parallel to the desired fitting **101** and rotates the tool **200** such that opening **224** is presented to the fitting **101**. More specifically, the technician aligns the opening **224** such that aperture **214** is set to engage the circumferential groove **133** of the locking collar **131**. The pocket **212** is preferably therefore aligned to receive and substantially encompass the outer ring **137** of the locking collar **131**, and the internal channel is set to accommodate the exposed top portion of the fitting **101**.

The removal tool **200** is then simply slip-fit onto the fitting **101** from the side. When fitting removal tool **200** is slip-fit over fitting **101**, the pocket **212** is engaged substantially around the locking collar **131**. Advantageously over the prior art, use of the fitting removal tool **200** does not require substantial uniform extra space surrounding the fitting **101**, but generally only enough space to accommodate placement of the fitting removal tool **200** adjacent to one side of the fitting **101**.

As shown in FIG. 3B, the technician may rotate **250** the grip **244** in the appropriate manner to cause threaded rod **242** to advance **252** swivel seat **270** towards the open end **105** of fitting **101**. As the pilot **282** engages opening of the fitting **101**, the tapered form of the pilot **282** may assist in properly aligning the fitting removal tool **200** to the fitting. Generally the technician will continue rotation of the grip **244** until the swivel seat has substantially engaged the fitting **101**. The placement and initial rotation of the grip **244** may advantageously be performed with only one hand – a desired ability in instances where the

fittings have been installed with limited view and hand / tool space. When the fitting removal tool **200** has been initially attached to the fitting **101**, the technician may let go of the fitting removal tool **200** with relative confidence that it will not accidentally fall or shift in position.

Extraction of the locking collar **131** is accomplished by the technician's appropriate rotation **250** of threaded rod **242** through the threaded base **210**. Specifically, the technician torques the grip **244** with sufficient force to induce the threads of the rod **242** to pass through the threads of the base **210**. The threads mechanically translate the rotation force into a lateral motion force. Acting as an inclined plane, the threads permit the technician to overcome the large resistance force by applying a relatively small force through a longer distance. As the swivel seat **270** is braced against the fitting, the lateral motion of the threaded rod **242** is not permitted. A substantially equal and opposite lateral force of motion, represented by arrows **290** results. A lateral motion of the housing **202** toward the grip **244** naturally results.

The integral nature of the pocket **212** to the housing **202** directs that as overall housing **202** moves, so to does the pocket **212**. Engaged about the locking collar **131**, the lateral motion of the pocket **212** effectively disengages the locking collar **131** from the mounting surface **183**, thus permitting the fitting **101** to be removed. The mating of the pocket **212** and the locking collar **131** provides sufficient friction to substantially prevent rotation of the housing **202** relative to the fitting. Under appropriate circumstances, the vertical sidewalls of the pocket parallel to the longitudinal axis **204** may provide vertical notches to engage the vertical serrations of the locking collar **131**. To provide a sufficient torque load to drive the threaded rod **242**, and correspondingly a greater lateral pulling force, the technician may use a ratchet driver with socket **248**.

Generally speaking, the fitting removal tool **200** is intended primarily for the purpose of disengaging the locking collar **131**. As the fitting removal tool **200** is, by design, intended to substantially prevent rotational torque from being applied to the fitting **101**, following the retraction of locking collar **131**, the fitting removal tool **200** is generally removed so that a drive socket may be placed over fitting **101**. The fitting removal tool **200** may be simply disengaged from the fitting **101** by rotating the grip appropriately to retract the swivel seat **270** from the fitting **101**. As the pulling force applied by the fitting removal tool **200** is in substantially direct alignment with the fitting **101** due to the cooperation of the swivel seat **270** and the pilot **212**, the process of extracting the locking collar **131** is substantially non-violent. Advantageously, with due inspection, the fitting **101** removed with the use of the fitting removal tool **200** may under appropriate circumstances be

recycled for use at a significant cost savings over simple discard and replacement.

While the invention has been described with reference to the preferred embodiment, it will be understood by those skilled in the art that various alterations, changes and improvements may be made and equivalents may be substituted for the elements thereof and steps thereof without departing from the scope of the present invention. In addition, many modifications may be made to adapt to a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Such alterations, changes, modifications, and improvements, though not expressly described above, are nevertheless intended and implied to be within the scope and spirit of the invention. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.